SECTION D:
FISHERIES SOCIO-ECONOMICS AND EXTENSION

CHARACTERISTICS OF DESIGNED GILL NETS OF VARIOUS MESH SIZES

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Abstract
The results of the investigation of characteristics of designed gill nets of various mesh sizes used in Kainji Lake are presented. Six different mesh sizes were used in the construction of the gill nets. 50.8mm mesh size had a mean catch of 389.3kg, (66.69%) followed by 88.9mm mesh size with a mean catch of 144.1kg (29.23 % of the total catch.) 101.6mm mesh size had a mean catch of 11.47kg (2.41%) while 152.4mm mesh size had a mean catch of 07.73kg (1.62 % of the total catch). The lowest catches were recorded in gill nets of mesh sizes 177.8mm which had a mean catch of 0.2kg and 190.5mm which had a mean catch of 0.06kg and percentages of 0.04% and 0.01% respectively. It was observed that gillnets with 88.9mm mesh size had the highest mean weight of 79.64kg, followed by gill nets with 50.8mm mesh size which had a mean weight of 27.44kg. Gillnets with 152.4mm mesh size caught fishes with a mean weight of 12.31kg while 101.6mm mesh size had a mean weight of fish of 3.26kg. Gillnets with 177.8mm mesh size caught fishes with a mean weight of 0.68kg while gill nets with 190.5mm mesh size caught fish with the group mean weight of 0.61kg. Although the gill net with 50.8mm mesh size had the highest mean catch, the gill net with 88.9mm mesh size had the preferable mean weight combined with the mean catch, which had significant difference ($P < 0.05$) in its favour when compared with the other (five) designed gill nets. Tilapia was the most abundant fish species throughout the period of sampling. Recommendations for the conservation of the fisheries resources of the lake were also proffered.
Keywords: Gillnet, Mesh-size, Mean-catch, Weight, Conservation, Fisheries-resources

Introduction

A gillnet is essentially a curtain-like netting material, hanging vertically in the water (Fig. 1). The netting material is usually made of R150 - 350 tex-nylon twine and 25.4 to 127mm stretched mesh sizes. Head and foot ropes pass through the marginal meshes and each of the net usually with hanging co-efficient ranging between 0.5 - 0.60. It can be set at the surface, mid-water or bottom part of water body. The net can also be operated actively by drifting it along the water body in horizontal column.

Gillnet effectiveness will depend on various factors including mesh size, exposed net area, floatation, mesh shape, hanging ratios, visibility and type of netting material in relation to stiffness and breaking strength (Van Brandt, 1984). In Nigerian Inland waters nets are constructed by using netting materials like monofilament and multifilament nylon netting hung on a single kuralon frame rope. The hanging ratio is usually 0.5 (50%), (KIFTIC, 1992).

Gillnet is used extensively by small-scale artisanal fishers in the brackish and coastal waters of Nigeria, being also the preferred fishing gear in Nigerian Inland water bodies. It has been reported that more than 75% of the fishers use gill net at one time or the other within a fishing season (Reed *et al.*, 1967). Gillnets are highly selective gears and hence the use of an appropriate mesh size prevents the catch of juveniles and makes possible the catch of a desirable narrow size range of fish (Hamley 1975). It has several advantages over other fishing nets since it does not depend on the availability of bait and require minimal use of fishing vessel. Gillnet has thus become the most widely used fishing method in both inshore and offshore fisheries. However, the cost of synthetic netting material has increased markedly in recent years and it is therefore important that they are constructed in such a way as to increase the maximum efficiency potential of the ensuing nets.

Some factors affect gillnet, and either directly or in combination with other factors affect their efficiency and selectivity. Efficiency (catchability) is defined as the proportion of fish caught by the gear while Selectivity is the relative efficiency per size.

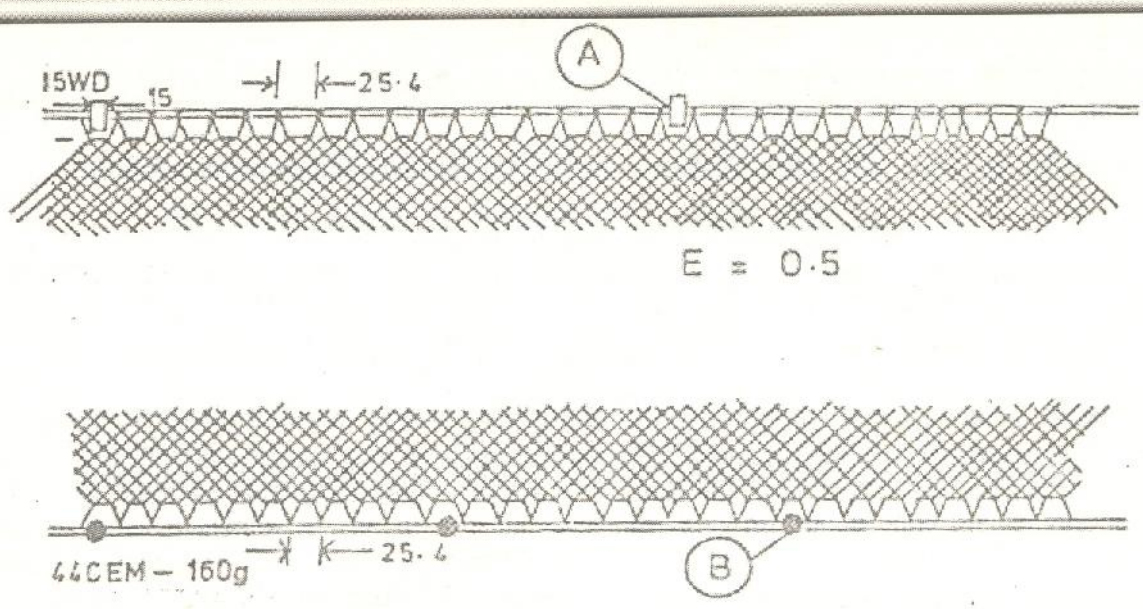

Figure 1: Diagrammatical representation a Gill-net

Keys: A Floater on the head-rope
B Sinker on the foot-rope
E = 0.5 Hanging ratio

Knowledge of the efficiency of gillnet is important for estimation of fish population in stock assessment. The effects of technical innovation by fishers on the efficiency of gillnet is quantified for proper fisheries management. Netting material type has been shown to greatly influence catches. Transparent monofilament netting material is effective as gillnet in clear water. This is invisible to the fish since visible nets tend to be avoided by fish. In turbid water, however the different in structure and colour of gillnet material is usually very small (Nedele, 1975).

Gillnet can be generally set on the surface, or mid water, or bottom of water. It is usually set and left over-night at a fishing ground. Gill nets are passive gears, but can be used as an active gear by dragging through water by the aid of a fishing boat. The catchability and selectivity of gill nets depend on the hanging ratio used for mounting it. This value is usually expressed as the relationship between the length of head rope of the net and length of respective netting section. Reduction of the hanging ratio increases the surface area of the net, thus increasing its visibility and making it more likely to be avoided by fish, since gillnet avoidance is primarily dependent on visibility. One way of estimating the selectivity of gillnet is by comparing the catch with that of a relatively unselective gear such as the trawl or the purse seine (Hamely, 1975).

Fishing gears are designed to produce the maximum efficiency potential for the minimum cost in material and labour input. Ita (1975), described gillnets as one of the most important traditional fishing gears used in the Lake Kainjii. It is necessary that netting materials be chosen whose mesh sizes conform to recommendations for actual exploitable fish sizes with the intention to protect juvenile fish from capture in water bodies.

The Objectives of this Study include: (a.) to study the characteristics of design gillnet in relation to mesh-sizes; (b.) to investigate fish catch composition in relation to families/genus; (c.) To assess dominant fish catch in relation to families/genus.

The study area

The Kainji Lake is located in the Niger State, Nigeria. It is 136km long and 24km wide with a maximum and mean depth of 60m and 11m respectively. Its surface area is 1270km^2, with storage capacity of 15.6x10^{9}m^3 of water. The annual fluctuation in water levels of the Kainji Lake is between 10 and 11m and it has a catchment area of 1.6x10km^2 (Fig. 2). The conductivity, surface temperature, total dissolved solid and pH are within the range of 33 - 84 mhos cm^{-1}, 20°C - 31°C, 34 - 50mgl^{-1} and 60.0 - 8.4(pH units) respectively. The lake is able to outflow its volume at about four times a year (Ratio 4:1), and 20% of the lake area at its highest level are liable to exposure during draw down period (Otobo (1977). Apart from the regular inflow of water from River Niger to the Lake, the reservoir experiences two major flood regimes namely the "white" and "black" floods.

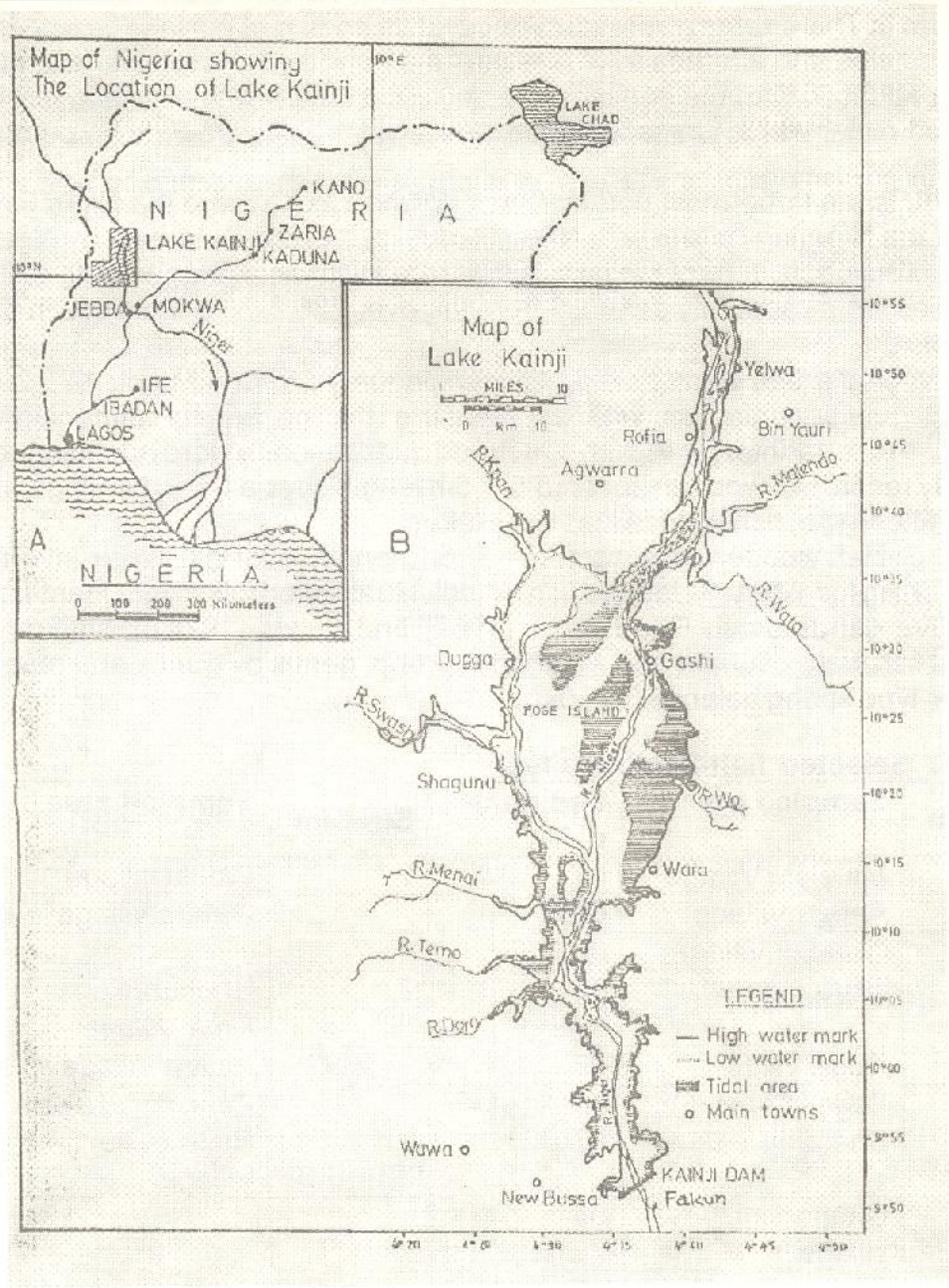

Fig. 2 (A) Map of Nigeria showing Kainji Lake
(B) Kainji Lake
Adapted from Obhahis, *et al.*, 2006;

The "white" flood is formed as a result of rainfall as far as from Mali Republic, which enters the lake as from late August every year and it's characterised by turbidity. The "black" flood which is derived from rainfall at the sour e of River Niger (Futa Djalon) enters the lake in November. It is characterised by high water transparency. Variation in annual inflow results in marked fluctuation in the surface area, depth and shoreline area of the lake.

Materials And Methods

Selection Of Sample Area: About 286 fishing localities (villages and camps) spread along the shoreline and Islands of Kainji Lake were divided into three strata as follows:

Stratum I: This is the Southern most of the Lake Basin starting at the dam site and terminates at the tip of the old Bussa Island. The basin covers an area of about 20% of the total surface area of the Lake. It is the deepest part of the lake with a maximum depth of over 60 metre near the dam wall and average depth of 18.5 metre with a maximum width of 5km the basin is also characterised by steep banks (both east and west bank).

Stratum II: This stratum represents the middle portion of the lake basin starting from where stratum I terminates and extends to where the lake narrowed down. It is the largest basin of the lake covering about 65% of the surface area and a maximum with of 24km. It is characterised by extended flood plain, which is seasonally exposed during the draw down period. It has a mean depth of 10.8m.

Stratum III: Is the uppermost portion (basin) of the Lake, where the Niger River enters it, and terminates at the Nigerian border with Niger Republic. It is characterised by steep banks, narrow channel and forms about 15% of the lake surface area with an average depth of 8.0m. Fifteen (15) fishing localities were randomly selected from the over 286 fishing localities in the three strata of the Lake (Table I)

The selected areas were visited between January 15th and March 15th, 2004 to administer the prepared questionnaire as well as measure the necessary dimension of the gillnets encountered. Personal interviews with structured questionnaire were administered.

Weekly records of wooden cover (5.5-7.5m length over-all) fish landings with gillnets as the only in use in fifteen (15) fishing localities were taken.

Gillnet wooden canoes (5.5 - 7.5m length over-all) were inventoried weekly in Fifteen (15) fishing localities. All landed fish by individual fisher-folks were identified and sorted into their respective genus using Reed *et al.* (1967) and Lewis (1974) identification/classification guide. Sorted fish were counted and weighed in group, genus by genus and recorded accordingly using a Salter-type spring balance (0 - 50kg).

Table 1: Selected fish-landing sites

Stratum	Sampled area	Designated	Stratum	Sampled area	Designated
1	Malelale Village	01	2	Waulu village	09
	Anfani Village	02		Gafara village	10
	Garafini Village	03			
	Wara Village	04	3	Uneku Village	11
				Ijima Village	12
2	Duga Village	05		Hiniya Village	13
	Foge Island	06		Zamare Village	14
	Shagunu village	07		Ruku Bello Village	15
	Chupamini village	08			

Respective gillnet design details including the mesh size, the fishing operation and the catch composition and catch per unit effort (kg) per canoe were recorded. Using a 50m linen measuring tape, information on the dimension and profile of the gillnet that caught the fish were also taken where possible. Headline measurement was taken as the distance from the beginning of a mount by using webbing meshes to the last one in a straight form. Mesh sizes of netting were taken by using a plastic metric/imperial rule (30cm/1ft type) as a mesh gauge. The mesh size was measured from one knot diagonally to the opposite one in a stretched mesh.

Data Analysis: The completed questionnaire were analysed to obtain the following information:- (i.) Type of mesh sizes used on the lake, their percentage occurrence and distribution in each stratum; (ii.) Catch composition and variation of each mesh sizes from stratum to stratum and (iii.) Genera/species that were most selected by the gillnets in terms of number and weight.

Results

Distribution of catches by number and weight for the various mesh sizes are presented in Tables 2 and 3. In Table 2 the number of fish caught by mesh size. 50.8mm, 88.9mm, 101.6mm, 152.4mm, 177.8mm and 190.5mm are 4,769, 2,090, 172, 116, 3 and 1 respectively. The total sum of fish caught by gillnets in the 3 Strata is 7,151. The mean catches by the nets in increasing mesh sizes are 389.3, 144.1, 11.47, 07.73 0.2 and 0.06. The percentage catches by the nets in increasing order of mesh sizes are 66.69%, 29.23%, 2.41% 1.62%, 0.04%, and 0.01% respectively.

Table 3, shows the distribution of catches in relation to weights. 411.6, 799.1, 49.1, 180.1, 10.3 and 9.2 kg of fish were recorded against mesh sizes 50.8mm, 88.9mm, 101.6mm, 152.4mm, 177.8mm and 190.5mm respectively. Percentage weights were 28.20%, 54.76%, 3.36%, 12.34%, 0.71% and 0.63% while varying mean weights of 27.44, 79.64, 3.26, 12.31, 0.68 and 0.61 were recorded against the nets in their increasing order of mesh sizes respectively.

Table 2: Distribution of catches (by number) in relation to gillnets varying mesh sizes of gillnets

Mesh size	Stratum 1				Stratum 2						Stratum 3					Total for the 3 stratum		
	Samples area				Samples area						Samples area					No. of Catch	Mean Catch	% Catch
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
50.8mm	48	224	245	0		3161	0	349	0	588	65	0	0	59	60	4799	389.3	66.69
88.9mm	0	0	0	18	332	88	1484	0	146	0	0	22	0	52	20	2090	144.1	29.23
101.6mm	0	74	4	3	0	0	0	79	0	12	0	0	0	0	0	172	11.47	2.41
152.4mm	0	18	22	0	76	0	0	0	0	0	0	0	0	0	0	116	07.73	1.62
177.8mm	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3	0.2	0.04
190.5mm	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0.06	0.01
Total																7151		100

Table 3: Distribution of catches in relation gillnets varying mesh size weight.

Mesh size	Stratum 1				Stratum 2						Stratum 3					Total for the 3 stratum		
	Samples Area				Samples area						Samples area					Total Weight (kg)	% Weight	Mean Weight (kg)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
50.8mm	9.4	27.9	34	0	0	258	0	29.7	0	33.5	6.5	0	0	9.6	3	411.6	28.20	27.44
88.9mm	0	0	0	3	132	429	588	0	22	0	0	12.4	0	7.2	1.1	799.1	54.76	79.64
101.6mm	0	18.4	5.2	1	0	0	0	20.1	0	4.2	0	0	0	0	0	49.1	3.36	3.26
152.4mm	0	17.7	29	0	138	0	0	0	0	0	0	0	0	0	0	180.1	12.34	12.31
177.8mm	0	0	0	0	0	0	10.3	0	0	0	0	0	0	0	0	10.3	0.71	0.68
190.5mm	0	0	0	0	0	0	9.2	0	0	0	0	0	0	0	0	9.2	0.63	0.61
Total																1459.4	100	123.94

Table 4, presents summary of gear selectivity of gillnets in the Kainji Lake Area. *Tilapia species* dominated all the catches with a total number of 3,270, with a percentage (%) of 45.55% and a weight of 208.54kg, *Labeo, Citharinus, Synodontis, Disticnodus, Hydrocynus* and *Alestes* follows with 1,730, 745, 652, 231, 281,and 242 respectively. *Synodontis* recorded the highest weight of (489.94kg) followed by *Distichodus* (254.37kg), *Hydrocynus* (165.49kg) and *Citharinus* (152.95) respectively, while *Labeo* recoded a lower weight of 146.96kg and *Alestes* recoded the a lowest/least weight of 41.15kg.

Table 4: Summary of gear selectivity by catch of seven species of fish in Kainji Lake

Genus	No. of catch	Catch (%)	Catch W eight (kg)	Weight (%)
Tilapia	3,270	45.55	208.54	14.29
Labeo	1,730	24.25	146.96	10.07
Citharinus	745	10.45	152.95	10.48
Synodontis	652	9.15	489.94	33.57
Distichodus	231	3.25	254.37	17.43
Hydrocynus	281	3.95	165.49	11.34
Alestes	242	3.40	41.15	2.82
Total.	**7,151**	**100**	**1,459.4**	**100**

Discussion

The distribution of gillnets encountered in the Kainji Lake varies. Stratum 2 comprising Doga, Shagunu, Chupanini, Foge Island and Garaffini have the highest number of gillnets. Incidentally, most of the fishing activities employing gillnet took place in these areas. A low record of gillnets utilization was observed in the other two strata, which suggest that other fishing gears such as cast nets, trap and beach-seine net may be in use there.

50.8mm mesh sizes recorded the highest catch throughout the sampling period (Table 2). This may be because 50.8mm is one of the smallest meshes that caught both big and small sizes of fishes. The low catch recorded in 190.5mm is due to the fact the mesh size are quite large hence most small fishes could pass through the mesh unhindered.

The highest weight and mean weight were recorded in the catches of meshes size 88.9mm. The fishes caught with this mesh size (88.9mm) were mainly large fish such as *Synodontis membranaecus,* while the low weight recorded in mesh size 50.8mm is as a result of small sizes of fish it caught. The Tilapia species that was predominate during the sampling period was a result of the fact that most Tilapia fingerlings could not escape the small mesh size of 50.8mm. From the foregoing it be deduced that the gillnet with mesh size 88.9mm had the preferable mean weight combined with the mean catch, with favourable significant different ($P < 0.05$).

The hanging ratio has a high influence on the efficiency of gillnets because of the influence on the shape of the mesh. It is recommended that gillnets should be mounted with 50% hanging ratio to increase efficiency of the net by entangling. The method of tying the stapling line in some gillnets should be changed. The net webbings slide along the headline at the slightest pull and the meshes assume irregular shapes, which affect the efficiency of the nets.

The use cement block sinkers, and corn or plastic floats, which are far, more durable than the wooden or raffia floats, is highly recommended. The relative increase in catches decreased with time. The quality of some of the catches deteriorated badly and where eaten by some carnivorous aquatic organism when gillnets were set for a long period of time such as for 10 hours. Checking of gillnets at an interval of four hours could improve both the quality and quantity of catch.

To make the nets last longer, it is recommended that the nets should be spread under shade instead of sun drying, which tend to weakened the netting material and make it tear easily. Twine size affects the useful life of the gillnets for example nylon gillnets made of R100 - 150 twine tend to damage more easily than nets with stronger twines of R250-350 tex.

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